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(54) Abstract Title

A method of routing communications between networks dependent on access levels

(57) A method for routing communications in a communication system comprising, a first communications network 4; a second communications network 10; and a third, local communications network 8 whose coverage area at least partially overlaps that of the second network. The third network comprises, an access unit 6 connecting the third network to the first, and a control unit 7 for controlling access to the third network 8 by the terminals. The terminals of the third network 8 are also capable of communicating in the second communications network 10. When a connection is to be initiated by one of the terminals 1 to another terminal 1 it is determined whether to establish the connection to the other terminal wholly within the third network 8, via the first network 4 or via the second network 10 based on the identity of the other terminal 1 and the level of access to the third network 8 that is available to both terminals.

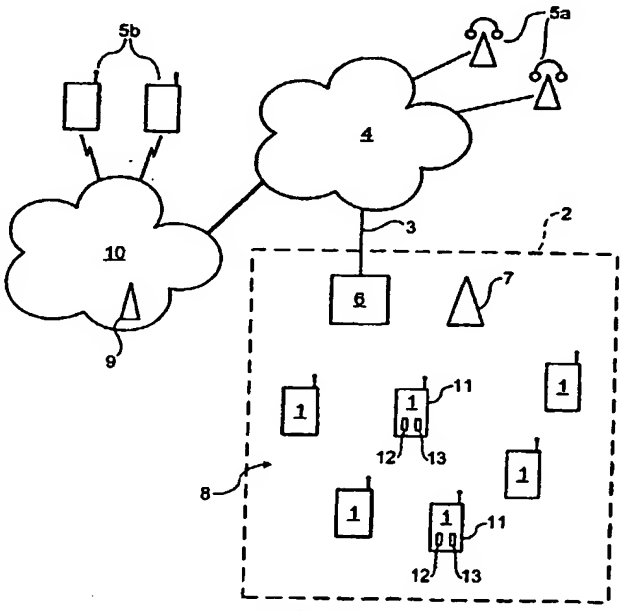

FIG. 1

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At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

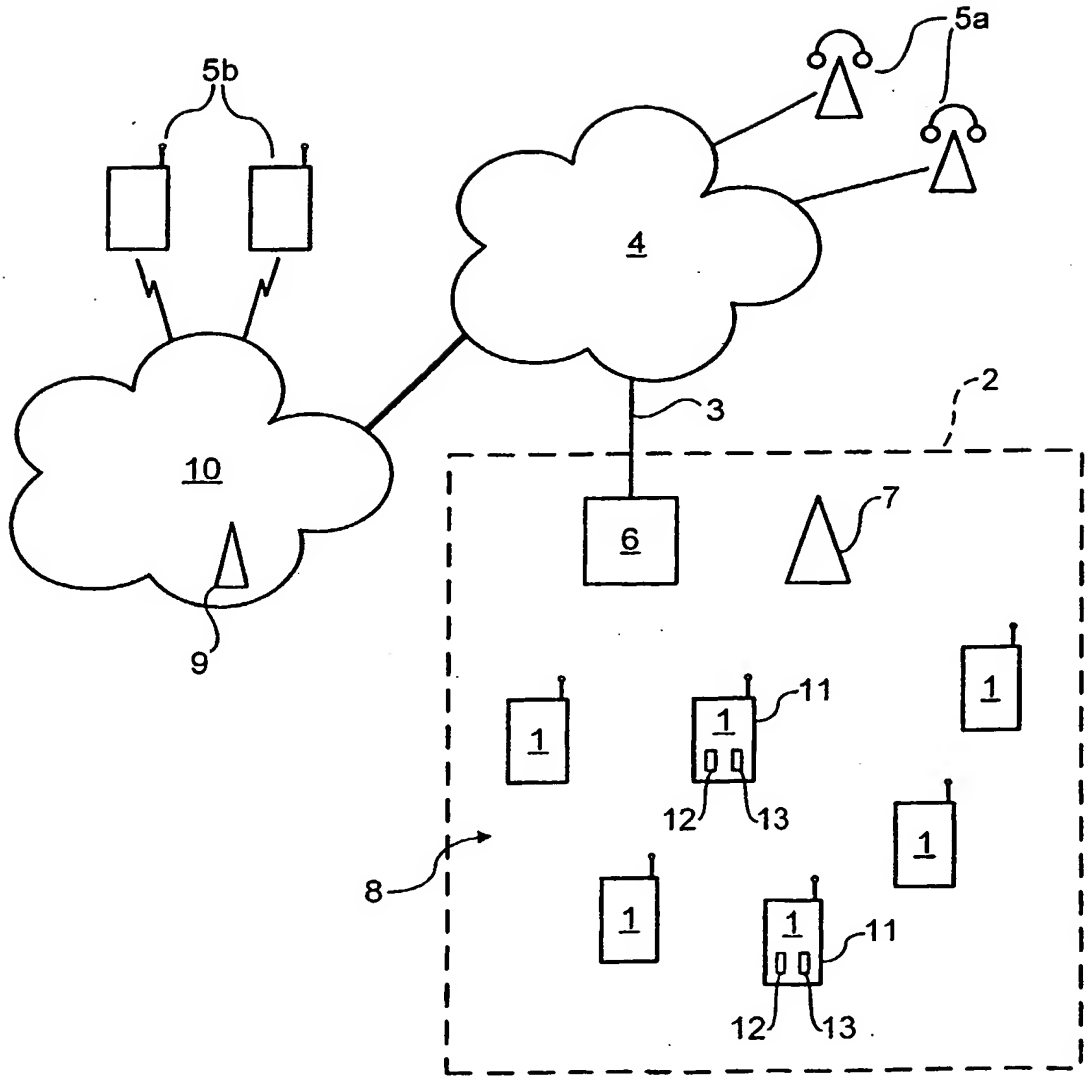

FIG. 1

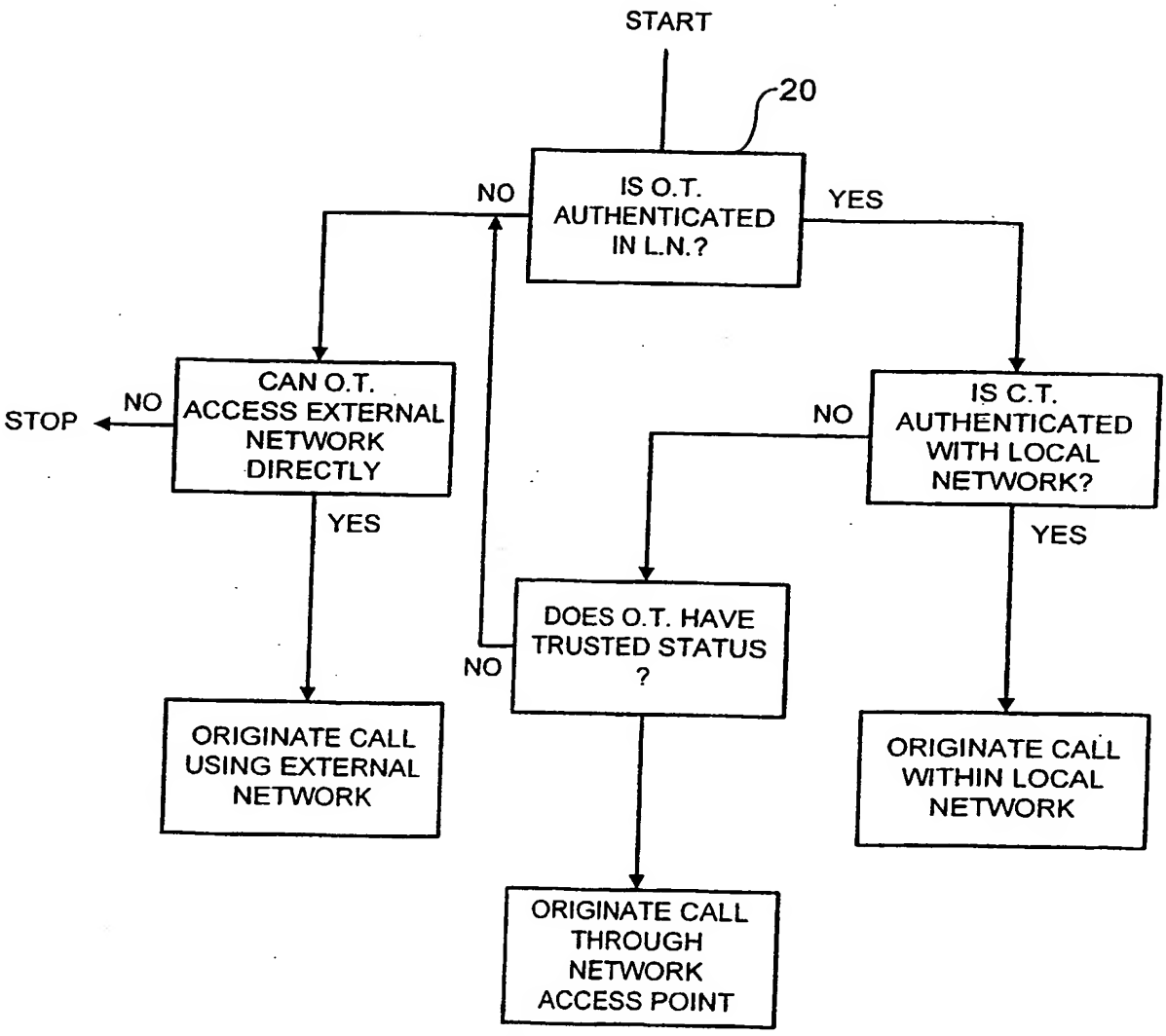
START
20
IS O.T. AUTHENTICATED IN L.N.?
NO
YES
CAN O.T. ACCESS EXTERNAL NETWORK DIRECTLY
STOP
NO
YES
IS C.T. AUTHENTICATED WITH LOCAL NETWORK?
NO
YES
DOES O.T. HAVE TRUSTED STATUS ?
NO
ORIGINATE CALL USING EXTERNAL NETWORK
ORIGINATE CALL WITHIN LOCAL NETWORK
ORIGINATE CALL THROUGH NETWORK ACCESS POINT

FIG. 2

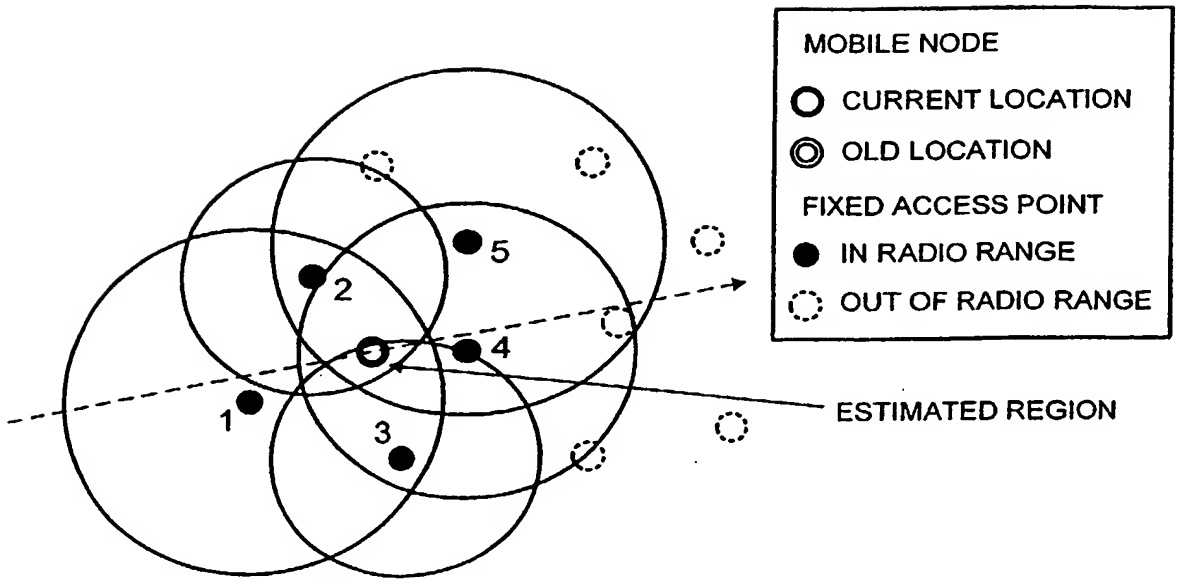
MOBILE NODE
CURRENT LOCATION
OLD LOCATION
FIXED ACCESS POINT
IN RADIO RANGE
OUT OF RADIO RANGE
ESTIMATED REGION
1
2
3
4
5

FIG. 3

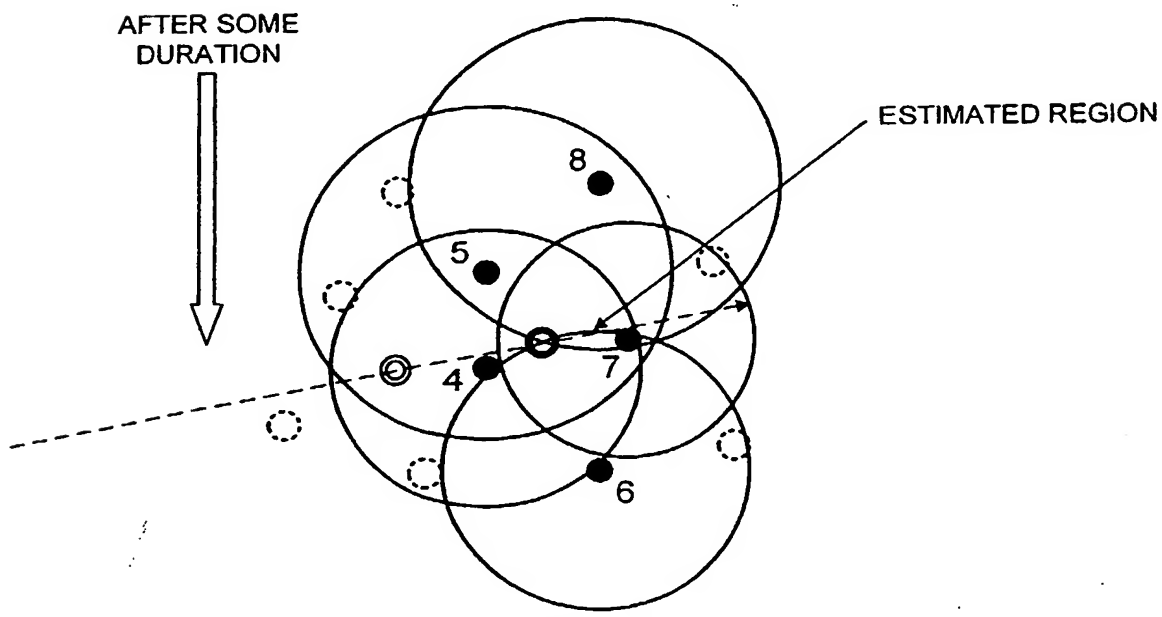
AFTER SOME DURATION
ESTIMATED REGION
4
5
6
7
8

FIG. 4

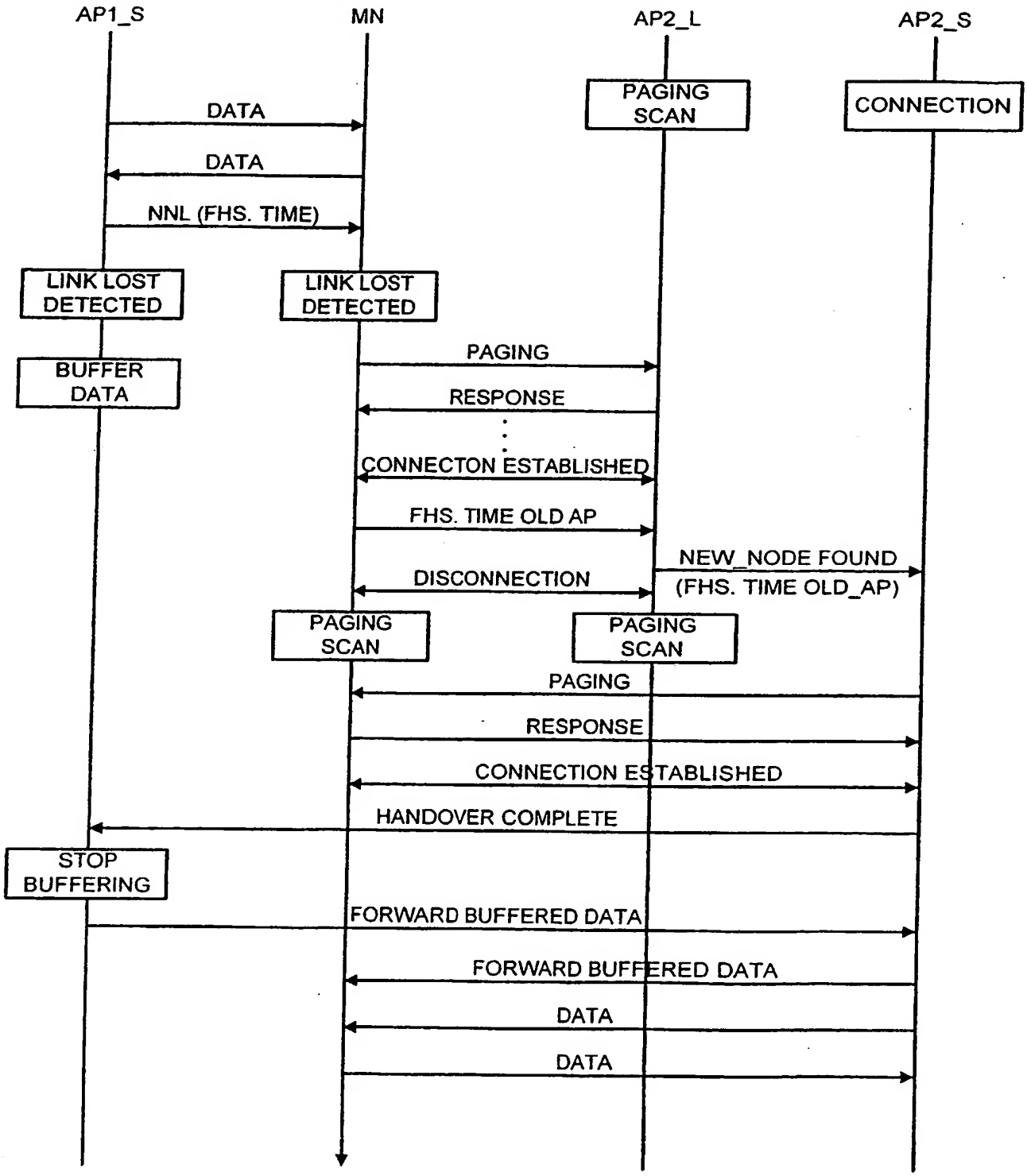
AP1_S
MN
AP2_L
AP2_S
PAGING SCAN
CONNECTION
DATA
DATA
NNL (FHS. TIME)
LINK LOST DETECTED
LINK LOST DETECTED
PAGING
BUFFER DATA
RESPONSE
CONNECTON ESTABLISHED
FHS. TIME OLD AP
NEW_NODE FOUND
(FHS. TIME OLD_AP)
DISCONNECTION
PAGING SCAN
PAGING SCAN
PAGING
RESPONSE
CONNECTION ESTABLISHED
HANDOVER COMPLETE
STOP BUFFERING
FORWARD BUFFERED DATA
FORWARD BUFFERED DATA
DATA
DATA

FIG. 5

ROUTING METHODS

This invention relates to methods for routing communications such as calls in a communication system. The communication system could, for instance, make use of the Bluetooth protocol.

In one form of domestic or office telephone installation there may be a number of handsets that can communicate using a wireless system such as Bluetooth, and one or more access points such as private branch exchanges (PBXs) by means of which the handsets can access an external communications network such as a public service telephone network (PSTN). Each handset may have a telephone number or other identification code which identifies it in the external network. The handsets may additionally be able to make contacts with remote terminals by connecting directly to another network, as in the case of dual mode handsets that can operate according to the Bluetooth and third generation (3G) mobile phone systems.

A user of one of the handsets may wish to contact another of the handsets, or may wish to contact a terminal in the external network. Since it can be expected that the operator of the external network will charge for its use, there is a need to control the routing of calls so that it is done in the most efficient way.

According to one aspect of the present invention there is provided a method for routing communications in a communication system comprising: a first communications network; and a second communications network; and a third, local communications network whose coverage area at least partially overlaps that of the second network, the third network having: an access unit whereby the third network is connected to the first network, a plurality of terminals capable of communicating with each other, the access unit and the control unit, at least one of the terminals being also capable of communicating in the second communications network; and a

control unit for controlling access to the third network by the terminals; the method comprising: determining that a connection is to be initiated by the said one of the terminals to another terminal having an identity whereby communications may be routed to it; and determining whether to establish the connection to the said other terminal wholly within the third network, via the first network or via the second network based on at least the identity of the said other terminal and the level of access to the third network that is available to the said one of the terminals. The invention also provides a corresponding system.

According to another aspect of the invention there is provided a handover system and a handover method having one or more features as set out herein.

Preferred features of the invention are set out in the dependent claims.

In the accompanying drawings:
figure 1 is a schematic diagram of a communication system;
figure 2 illustrates a routing algorithm;
figure 3 illustrates the movement of mobile nodes and their estimated locations in a communication system;
figure 4 illustrates the situation in the system of figure 3 after some time has elapsed; and
figure 5 illustrates message flow in a handover method.

The present invention will now be described by way of example with reference to the drawings.

Figure 1 illustrates a communications system. The system comprises a number of terminals 1 in a home or office 2. In this example the terminals are portable handsets that can communicate using a low-power radio frequency (RF) protocol such as Bluetooth. Thus the terminals form part of a local network at the home/office 2, which is indicated generally as network 8. The home/office 2 has a connection 3 to a public service network 4, such as a PSTN, to which other, remote

terminals 5a are connected. At the home/office the connection 3 terminates in an access point 6 which can communicate using the same protocol as the terminals 1. The terminals 1 can communicate via the access point 6 with the terminals 5. There is also a local network controller 7 which acts to supervise the operation of the local network. In this example the network controller is a Bluetooth access point.

The functions of the access point 6 and the network controller 7 could be combined in one unit physical or dispersed between a number of units.

The network 4 could be a land-line telephone network.

In the present system the local network is configured so as to enable routing of calls from the terminals 1 to be performed in a relatively efficient way.

When a terminal is to be used in the local network at the home/office 2 its identity is provided to the local network controller. The identity may be transmitted over the air to the network controller by the terminal itself. The local network controller authenticates the terminal according to pre-defined access rules stored in the controller.

The local network controller distinguishes between two classes of terminals in the local network. The classes differ in the access rights that they have to the public service network 4.

1. Restricted terminals. These terminals are not permitted to originate calls to terminals 5 via the access point 6. Thus they cannot cause charges to be incurred for use of the network 4. These terminals can, however, receive calls made to them by terminals 5 and that are incoming to the local network via the access point 6. For example, handset terminals belonging to visitors may be put by the controller in the restricted terminals class.
2. Trusted terminals. These terminals are permitted to initiate and receive calls using the network 4 via the access point 6. These terminals could be handsets belonging to owners of the home/office 2.

The local network controller is pre-programmed with a set of access rules that allow it to authenticate terminals and allot them to one of the terminal classes. For example, a list of the identities of terminals that are to be trusted terminals may be pre-stored in the local network controller. The controller may additionally be programmed with an indication of whether other terminals that are not in that list should be denied authentication or should be permitted to authenticate with restricted terminal class.

The local network controller stores a list of the identities of all the terminals that are authenticated on the local network and the class of each one. When an additional terminal is authenticated on the network the controller transmits to it the identities of all the other terminals that are authenticated on the network, together with their classes. That list is stored by the terminal. To purge stale information from the list the controller periodically checks that the authenticated terminals are accessible through the network, updates its list accordingly and transmits the updated list to the remaining terminals. This may be done by the controller querying each terminal, or by each terminal being arranged to periodically transmit a signal (e.g. a broadcast signal) to indicate to the controller that it is present.

In the present system, the identity of each terminal 1 could be allocated in a number of ways. However, it is most convenient if each terminal's identity is allocated according to a common scheme in cooperation with the operator of the network 4. In this way each terminal can be given an identity that can be used by other terminals, whether local or remote, to identify the terminal for directing calls to it. Such an identity may be a conventional telephone number, ISDN or MSISDN number.

At least some of the terminals 1 can communicate directly with nodes outside the local network 8, for example with base station 9. This may be done using the same protocol as is used in the local network (e.g. Bluetooth) or another protocol. Preferably the protocol that is used is a mobile telephony protocol such as the third

generation (3G) mobile communication protocol. The base station 9 is an access point for another network 10 which is connected to network 4. Other terminals 5b are connected directly to network 10. Terminals 11 are example of terminals that belong to the set of terminals 1 and can also communicate directly with base station 9. For this purpose terminals 11 each have two radio transceiver units: one (12) for communication in the local network and one (13) for communication with base station 9.

A user may wish to make a call using one of the terminals 1 (originating terminal). The way in which the call is handled depends on the capabilities of the terminal, the class of the terminal and the identity of the terminal to which the call is to be made (called terminal, CT). The logic that is applied is illustrated in figure 2.

1. If the originating terminal (OT) is not authenticated with the local network (LN) then it cannot originate the call in the local network. (Box 20 in figure 2). In that case, if the terminal has the capability to communicate directly with an access point outside the local network (e.g. base station 9) then it may attempt to originate the call through that access point. (Box 21). That would be done at no cost to the owner of home/office 2 since he is not responsible for connections directly to network 10. If that is successful then the terminal can make its call. It should be noted that the call may be to another one of the terminals 1 that has authenticated in local network 8. If so, the call could pass via base station 9, network 10, network 5, connection 3 and access point 6.

2. If the originating terminal has authenticated with the local network then it will have a list of the other terminals authenticated in the local network. It checks whether the terminal to which the call is to be placed is one of those terminals. (Box 22). If it is then the terminal makes the call solely through the local network. (Box 23). This may be done by the originating terminal communicating directly with the called terminal, or via local network controller 7 or another relay station in the local network. Either way, the call does not use connection 3 or network 4 so no charge is made by the operator of network 4. If the call is made via a relay station then the network controller 7 may be responsible for determining how to direct the call. In that case the originating terminal may not need to have a list of the other

authenticated terminals.

3. If the originating terminal has authenticated with the local network and the called terminal is not authenticated with the local network then if the originating terminal has trusted terminal status (box 24) it makes the call through the access point 6 and, via connection 3, network 4. (Box 25). It is to be expected that a charge will be made by the operator of network 4, but this is permitted since the originating terminal has trusted status. Again, the routing of the call may be determined by the originating terminal using its list of authenticated terminals, or by the network controller 7.

4. If the originating terminal has authenticated with the local network and the called terminal is not authenticated with the local network then if the originating terminal does not have trusted terminal status it can, if it has the capability to communicate directly with an access point outside the local network (e.g. base station 9), attempt to originate the call through that access point. (Box 21). That would be done at no cost to the owner of home/office 2 since he is not responsible for connections directly to network 10. If that is successful then the terminal can make its call.

The algorithm set out above is based on the assumption that calls that are originated through network 4 are likely to be cheaper than those that are originated through network 10. If the costings are more complex then the unit that is responsible for determining the routing: the originating terminal or controller 7 could take cost into account in determining which route to select. The local network may be provided with connections to other external networks. For example, it could have a direct connection via another access unit (not shown) to network 10. That would allow further optimisation of cost.

The local network could use another protocol instead of or in addition to Bluetooth. For example, it could be a DECT (Digital European Cordless Telephone) network, or a packet switched cable network. It is preferably a wireless network.

The external network 10 is preferably a wireless network, most preferably a radio network. Its geographical coverage overlaps that of the local network.

In wireless networks having mobile terminals, as may potentially be used in the networks 4 and 10 of figure 1, when a terminal moves from the domain of one base station to that of another there is a need to hand over control of the terminal from one of the base stations to the other. Conventionally, the movement of the terminal away from one base station and towards another is detected by means of received signal strength (RSSI: received signal strength indicator): either received signal strength as detected by the terminal for signals from the base stations, or received signals strength as detected by the base stations for signals from the terminal. But there is an increasing trend where some of the general-purpose LPRF (low power radio frequency) modules that are available may not report this information to the software managing the devices. The absence of RSSI would make most of the existing handover algorithms not operable on these types of devices. One example of such a class of devices is at least some Bluetooth devices. In this and other situations it may be desirable not to use RSSI as a measure for handover control. Figures 3 and 4 illustrate a method which can help to address the problem of detecting movement of a mobile station without using RSSI.

In summary, this method involves the estimation of the location of the mobile node as an estimated region and the rough movement of the mobile node. Any algorithms using the information of distance from access points and the speed and the direction of mobile node can be employed in addition to this process. Therefore, embodiments of this method can enable highly efficient handover in networks without the use of RSSI.

The method involves estimating the approximate local position of a mobile node only with the information that can generally be gleaned without deploying any special purpose devices. Given the maximum power levels of access points, their geometric positions, and the LPS of the mobile node, the algorithm can be used to minimise or at least reduce the number of handovers. This can help to decrease the bandwidth overhead related with handover and increase channel utilization.

Assumptions:

1. All access points know their geometric position with respect to some reference point. This is not an unreasonable assumption because in many networks most of the access points tend to be fixed.
2. We assume that the access points are deployed in such a way that the area of operation of the access points covers the geometric area of interest.
3. Each of the access points knows the maximum power it can use to cover a mobile node that is at the periphery of its coverage area.
4. Each of the mobile nodes is capable of listening on different channels of different access points. In the case of Bluetooth it could be that the potential access points (APs) that a mobile node (MN) listens to can be obtained from the serving AP. The MN can then listen to the transmissions on those channels by inquiry, paging, or synchronizing to those channels. This capability could be built into other classes of devices.

The general procedure for estimating LPS of a mobile node is as follows. Whenever a MN accesses a new AP (serving AP) it gets a list of potential access points that the MN may be able to listen within the coverage area of the serving AP. Periodically the MN listens on the channels of the potential AT, and gathers the information regarding each access point's position (xi, yi) and maximum power that it can listen to. This information can be embedded in either access point advertisements, or as separate protocol packets. The list of the APs that it can listen to is stored in the MN's memory as a NNL (neighbour node list). Whenever this list changes, the access point would calculate the rough area of its positing by solving for the geometric intersection of the APs coverage area in the NNL. By keeping track of the past positions of the MN, and the time intervals between changes in the NNL, an MN would be able to predict its position, the movement direction, and the speed. When a MN detects that it is at the edge of the coverage area of serving AP (by comparing the MN's rough position, the currently serving AP's position, and the serving APs coverage area) it would start the determining the next AP that would become its serving AP (an AP in NNL that is furthest from the MN in the same direction as the movement of the MN, and also having enough capacity to accept

the MN). The MN would then initiate the handover process. It would inform the serving AP about the new AP to forward packets that are to be buffered during handover. It would then connect to the new AP. Once the connection is established, the old AP would transfer the buffered packets to the serving AP thus completing MN centric soft handover.

Figure 5 illustrates another algorithm usable in Bluetooth and other systems.

In they system of figure 5, each access point has two Bluetooth interfaces. One interface is mainly used for data forwarding, and is called a service interface; the other interface is mainly used for the establishment and maintenance of connection, and always stays in page scan mode, and is called a listening interface.

Each access point maintains a network neighbour list (NNL), which contains the Bluetooth address and the frequency hopping sequence (FHS) information for the listening interfaces of neighbour nodes.

When an MN connects with an access point, it receives the NNL from that access point periodically. Entries in the NNL may be sorted by the possibility of AP that MN will be handed over. This possibility can be determined by some local positioning system or movement detection algorithm.

When an AP detects the link to an MN is lost, it begins to buffer all the packets that are to be sent to that MN. At the MN's side, when it detects that link to the AP has been lost, the MN begins to page access points listed in the NNL in sequence. Because the listening interface of the neighbour access point is always in page scan mode, a connection can be established within a short period of time. After a connection between the listening interfaces of the AP and the MN is established, the MN forwards its own FHS and Bluetooth address information to AP's service interface via AP's listening interface, and then, disconnects the connection and enters paging scan mode. At the AP's side, the service interface pages the MN as soon as it has spare time slot to do. After the connection between the service

interfaces of the AP and the MN is established, the current AP notifies the MN's previous AP. The old access point would transfer the buffered data and send a route update packet to the concerned nodes that contain routes to the mobile node.

Another handover method that could be used in Bluetooth and other systems will now be described.

1. When an access point detects link loss, it sends a handover notification packet (HONP), which contains the Bluetooth address and clock information of the MN to be handed over, to all its candidate access points. At the same time, it starts to buffer the data packets destined to that MN and enables a handover timer. When a mobile node detects link loss, it disconnects the physical link but keeps the upper layer connection, then enters continuous page scan mode and enables a handover timer.
2. On receiving the HONP, each neighbouring access point waits for a random period of time, then pages the MN by using the information provided in the HONP. It also sets a paging timeout interval.
3. If a connection reply is received from the MN, the access point sends back to the previous access point a handover successful packet. If there is no connection reply received within the paging timeout, the paging process is stopped.
4. The previous access point sends the ongoing session information of the handed-over MN to the new access point, sends a stop-paging packet to other neighbouring access points, and starts to forward the buffered data packets to the new access point. At the same time, a route change protocol is sent along the old route to inform entities on that route of the handover of the MN.
5. The new access point sends a route change protocol message to the destination according to its routing table to inform of the handover of the MN. This route may be completely new and shorter than the old one.
6. If no handover successful packet is received by the time the handover timer times out, the access point that initiates handover will send a disconnection protocol packet along the existing route to release the resources. The mobile node will also release its internal resources when the handover process times out.

The applicant draws attention to the fact that the present invention may include any feature or combination of features disclosed herein either implicitly or explicitly or any generalisation thereof, without limitation to the scope of any definitions set out above. In view of the foregoing description it will be evident to a person skilled in the art that various modifications may be made within the scope of the invention.

CLAIMS

1. A method for routing communications in a communication system comprising:

i. a first communications network; and

ii. a second communications network; and

iii. a third, local communications network whose coverage area at least partially overlaps that of the second network, the third network having:

a. an access unit whereby the third network is connected to the first network,

b. a plurality of terminals capable of communicating with each other, the access unit and the control unit, at least one of the terminals being also capable of communicating in the second communications network; and

c. a control unit for controlling access to the third network by the terminals;

the method comprising:

determining that a connection is to be initiated by the said one of the terminals to another terminal having an identity whereby communications may be routed to it; and

determining whether to establish the connection to the said other terminal wholly within the third network, via the first network or via the second network based on at least the identity of the said other terminal and the level of access to the third network that is available to the said one of the terminals.

2. A method as claimed in claim 1, wherein if the identity of the said other terminal indicates that it is one of the said plurality of terminals then the connection is established wholly within the third network.

3. A method as claimed in claim 1 or 2, wherein the level of access indicates whether the said one of the terminals is permitted to initiate connections through the access unit to the first network.

4. A method as claimed in claim 3, wherein if the level of access indicates that the said one of the terminals is not permitted to initiate connections through the access unit to the first network then the connection is initiated through the second network.

5. A method as claimed in claim 3 or 4, wherein if the level of access indicates that the said one of the terminals is permitted to initiate connections through the access unit to the first network then the connection is initiated via the access unit and the first network.

6. A method as claimed in any preceding claim, wherein the step of determining whether to establish the connection is performed by the said one of the terminals.

7. A method as claimed in any preceding claim, wherein the first network is a land-line network.

8. A method as claimed in any preceding claim, wherein the second network is a wireless network.

9. A method as claimed in claim 8, wherein the second network is a radio telephony network.

10. A method as claimed in any preceding claim, wherein the third network is a wireless network.

11. A method as claimed in claim 10, wherein the third network is a low power radio frequency network.

12. A communication system comprising:

i. a first communications network; and

ii. a second communications network; and

iii. a third, local communications network whose coverage area at least partially overlaps that of the second network, the third network having:

a. an access unit whereby the third network is connected to the first network,

b. a plurality of terminals capable of communicating with each other, the access unit and the control unit, at least one of the terminals being also capable of communicating in the second communications network; and

c. a control unit for controlling access to the third network by the terminals;

the third network including means for:

determining that a connection is to be initiated by the said one of the terminals to another terminal having an identity whereby communications may be routed to it; and

determining whether to establish the connection to the said other terminal wholly within the third network, via the first network or via the second network based on at least the identity of the said other terminal and the level of access to the third network that is available to the said one of the terminals.

13. A method of handover in a telecommunications system having one or more of the features described herein.

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Application No: GB 0131044.0
Claims searched: All

Examiner: Steve Evans
Date of search: 23 June 2003

Patents Act 1977 : Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
A		WO 96/35309 A (INTERWAVE) - Whole document

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC[V]:

H4L

Worldwide search of patent documents classified in the following areas of the IPC[7]:

H04Q

The following online and other databases have been used in the preparation of this search report:

WPI, EPODOC, JAPIO